Polarization reversal in Rb:KTP and KTA single crystals

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The periodically poled crystals of potassium titanyl phosphate (KTP) family are one of the popular nonlinear optical materials. The KTP family includes crystals with various composition and doping. Among them the Rb doped KTP (Rb:KTP) and potassium titanyl arsenate ($KTiOAsO_4$, KTA) crystals possess the properties outperforming the basic KTP crystals. Rb:KTP crystals have lower bulk conductivity and KTA crystals have wider transparency range up to 5.5 µm. Realization of highly efficient nonlinear optical interaction requires the creation of precise periodical domain structure in the crystal. Despite the interest to creation of tailored domain structures in these perspective representatives of KTP family the systematical study of domain structure evolution and domain wall motion has not been published yet. In this work we present the study of domain structure evolution and domain wall motion in Rb:KTP and KTA single crystals.

The studied Rb:KTP and KTA Z-cut 1-mm-thick plates with bulk conductivity at room temperature about $2 \bullet 10^{-7}$ $Ohm^{-1}cm^{-1}$ were grown by top-seeded solution method. The polarization reversal was carried out using liquid electrodes.

In situ visualization of domain kinetics during polarization reversal allowed revealing the formation and fast growth of large number of narrow domain streamers oriented along [010] direction with about ten times higher velocity (6-60 mm/s) than the domain walls (2-5.5 mm/s). Study of the static domain structures demonstrated that the streamers are formed by [100] and [010]-oriented domain walls. The minimal streamer width was about 500 nm and minimal distance between the neighboring streamers – about 100 nm. The switching currents were approximated using the modified Kolmogorov-Avrami approach [2] taking into account the abrupt decrease of the growth dimensionality when the streamers reach the opposite electrode edge.

The polarization reversal in the temperature range allows to reveal the increase of the input of fast and superfast domain walls [3] and noticeable domain elongation with temperature. The domain wall velocities were measured, and corresponding activation energies were extracted.

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